Free-Standing Mathematics Qualification
June 2008
Advanced Level

WORKING WITH ALGEBRAIC AND GRAPHICAL TECHNIQUES
Unit 11

6991/2

ASSESSMENT and QUALIFICATIONS ALLIANCE

Tuesday 13 May 2008 9.00 am to 10.30 am

For this paper you must have:
- a clean copy of the Data Sheet (enclosed)
- an 8-page answer book
- an answer sheet for use in Questions 1, 2, 3, 4 and 5 (enclosed)
- a calculator
- a ruler.

Time allowed: 1 hour 30 minutes

Instructions
- Use black ink or black ball-point pen. Pencil should only be used for drawing.
- Write the information required on the front of your answer book **and** on the top of the answer sheet for Questions 1, 2, 3, 4 and 5.
- The *Examining Body* for this paper is AQA. The *Paper Reference* is 6991/2.
- Answer **all** questions.
- Show all necessary working; otherwise marks for method may be lost.
- The **final** answer to questions requiring the use of tables or calculators should normally be given to three significant figures.
- You may **not** refer to the copy of the Data Sheet that was available prior to this examination. A clean copy is enclosed for your use.
- At the end of the examination remember to hand in both your answer book **and** the answer sheet for Questions 1, 2, 3, 4 and 5.

Information
- The maximum mark for this paper is 60.
- The marks for questions are shown in brackets.
- You may use either a scientific or a graphics calculator.

SECTION A

Answer **all** questions.

Use **Ticket sales** *on page 2 of the Data Sheet.*

1 A model for the number of tickets sold, N, at time t days after they went on sale is given by the equation

$$N = 20t - t^2 \quad \text{for} \quad 0 \leqslant t \leqslant 20$$

Use this model to answer the following questions.

(a) On the answer sheet, plot the graph of N against t for $0 \leqslant t \leqslant 20$. *(3 marks)*

(b) Write down the maximum number of tickets sold in one day and the value of t at the maximum. *(2 marks)*

(c) For how many days were the tickets on sale? *(1 mark)*

(d) (i) Rearrange $20t - t^2$ in the form $p - (t - q)^2$ where p and q are constants. *(3 marks)*

(ii) The values of p and q are related to your answers in part (b).

What do the values p and q represent? *(2 marks)*

SECTION B

Answer **all** questions.

Use **Car efficiency** *on page 2 of the Data Sheet.*

2 The fuel consumption, C miles per gallon, can be modelled by the equation

$$C = \frac{a}{S} + b$$

where S is the speed in miles per hour and a and b are constants.

(a) On the answer sheet, complete the table of values, giving the values of $\frac{1}{S}$ to 3 decimal places. *(2 marks)*

(b) Use the grid on the answer sheet to plot C against $\frac{1}{S}$.

Draw a line of best fit on your graph. *(2 marks)*

(c) Use your graph to find the values of a and b. *(3 marks)*

(d) Use your values of a and b in the equation $C = \frac{a}{S} + b$ to find:

(i) the fuel consumption when the speed is 65 miles per hour; *(1 mark)*

(ii) the speed when the fuel consumption is 55 miles per gallon. *(2 marks)*

(e) The answer sheet shows the graph of C against S for a different car.

On the same set of axes draw the graph of the inverse function. *(3 marks)*

Turn over for the next question

SECTION C

Answer **all** questions.

Use **Airport growth** *on page 3 of the Data Sheet.*

3 (a) The number of passengers, N million, at time t years after 1990 can be modelled by the equation

$$N = 10.2 \times 1.0529^t$$

Use this model to calculate:

(i) the number of passengers in 1998; *(2 marks)*

(ii) in which year the number of passengers will exceed 30 million for the first time. *(3 marks)*

(b) Another model for the number of passengers at time t years after 1990 is given by the equation

$$N = 10.2 \times t^{0.2855}$$

Use this model to calculate:

(i) the number of passengers in 1998; *(2 marks)*

(ii) in which year the number of passengers will exceed 30 million for the first time. *(3 marks)*

(c) Explain why you cannot use the model in part (b) to find the number of passengers before 1990. *(1 mark)*

(d) On the answer sheet, sketch the graphs of the two models on the same set of axes.

Label each graph. *(3 marks)*

SECTION D

Answer **all** questions.

Use **Tides** *on page 3 of the Data Sheet.*

4 The height of the tide, h metres, can be modelled by the equation

$$h = 4.0 + 2.2\sin(30t)^\circ \quad \text{for} \quad 0 \leqslant t \leqslant 12$$

where t hours is the number of hours since midnight.

(a) Use the copy of the tides graph on the answer sheet to:

(i) find the height of the tide when $t = 4$; *(1 mark)*

(ii) find the times when the height of the tide is 3 metres; *(2 marks)*

(iii) find the gradient of the graph when $t = 4$; *(2 marks)*

(iv) state the units of the gradient. *(1 mark)*

(b) When $t = 7$, the actual height of the tide is 2.95 m.

Calculate the percentage error in the height of the tide when using the model with $t = 7$. *(3 marks)*

(c) Describe fully the transformations that map the graph of the function $h = \sin t^\circ$ onto the graph of the function $h = 4.0 + 2.2\sin(30t)^\circ$. *(3 marks)*

(d) Why is the model $h = 4.0 + 2.2\sin(30t)^\circ$ not suitable for the graph shown on the data sheet? *(1 mark)*

Turn over for the next question

5 The height of the tide, h metres, can be modelled by the equation

$$h = 4.0 + 1.8\sin(28t - 336)^\circ \quad \text{for} \quad 12 \leqslant t \leqslant 24$$

where t hours is the number of hours since midnight.

(a) On the copy of the tides graph on the answer sheet, plot the graph of

$$h = 4.0 + 1.8\sin(28t - 336)^\circ \quad \text{for} \quad 12 \leqslant t \leqslant 24 \qquad \textit{(4 marks)}$$

(b) For the equation $h = 4.0 + 1.8\sin(28t - 336)^\circ$, state:

(i) the amplitude; *(1 mark)*

(ii) the period; *(1 mark)*

(iii) the maximum height of the tide in the period $12 \leqslant t \leqslant 24$; *(1 mark)*

(iv) the minimum height of the tide in the period $12 \leqslant t \leqslant 24$; *(1 mark)*

(v) the time in the period $12 \leqslant t \leqslant 24$ when the tide is at its minimum height. *(1 mark)*

END OF QUESTIONS

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Surname		Other Names	
Centre Number			Candidate Number				
Candidate Signature									

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Unit 11

6991/2AS

ASSESSMENT and QUALIFICATIONS ALLIANCE

This answer sheet is to be used when answering Questions 1, 2, 3, 4 and 5 as indicated. Fasten this sheet securely to your answer book.

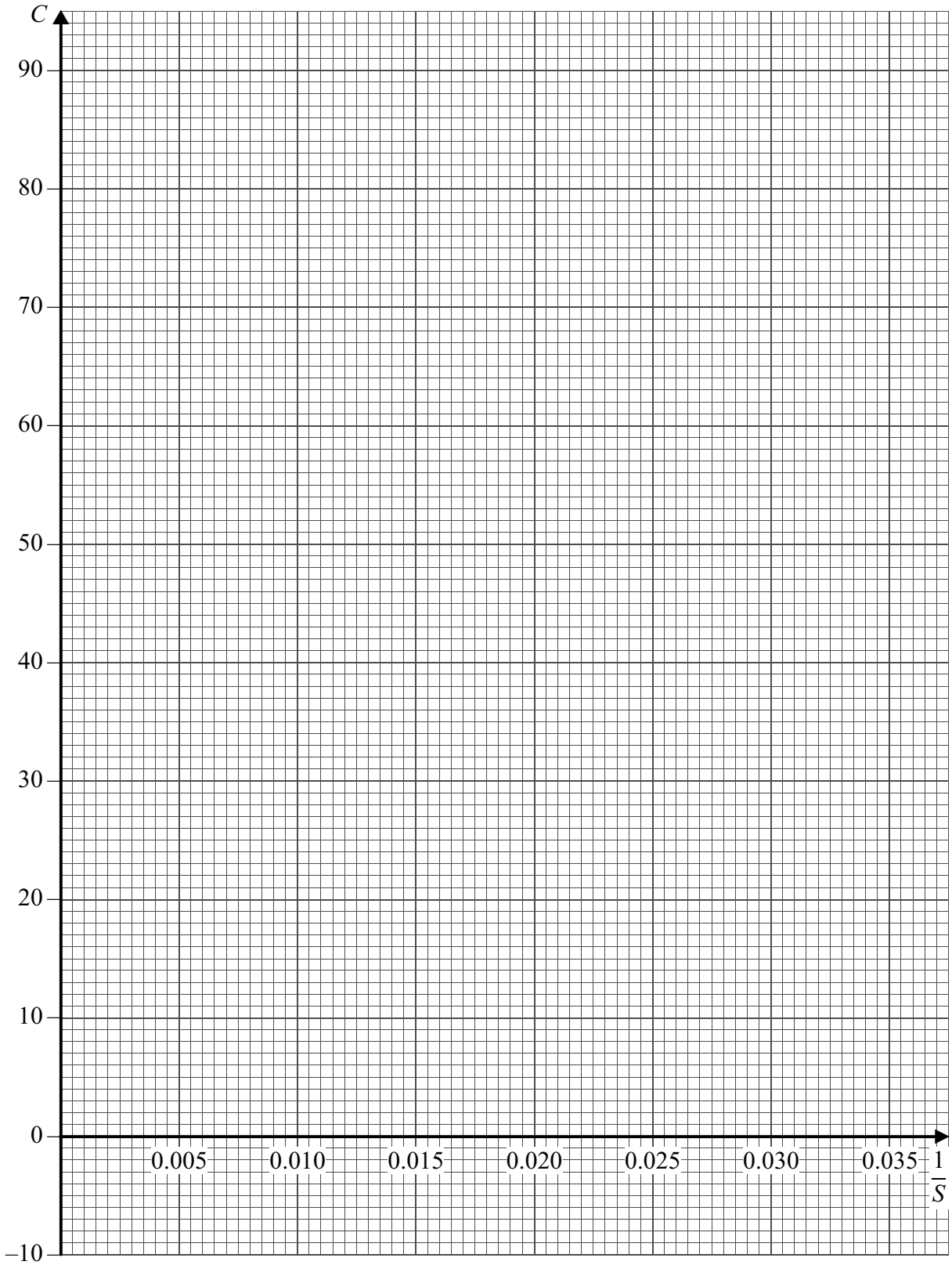
This graph is to be used when answering Question 1.

(a)

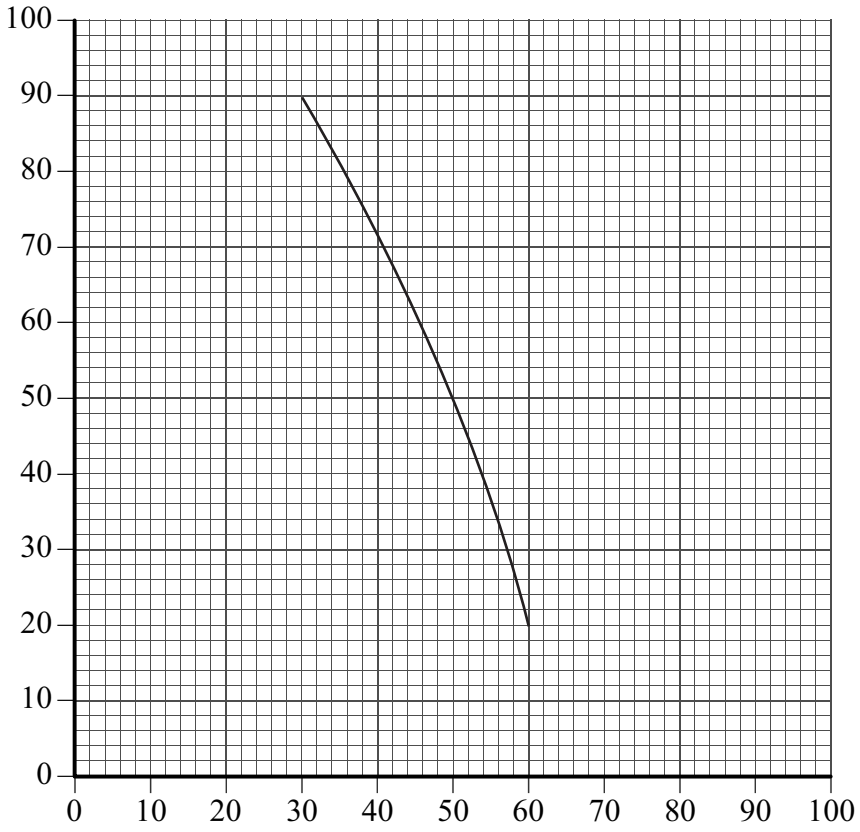
This table is to be used when answering Question 2 (a).

S	90	80	70	60	50	40	30
$\frac{1}{S}$							
C	26	30	35	40	50	63	85

This graph is to be used when answering Question 2 (b).

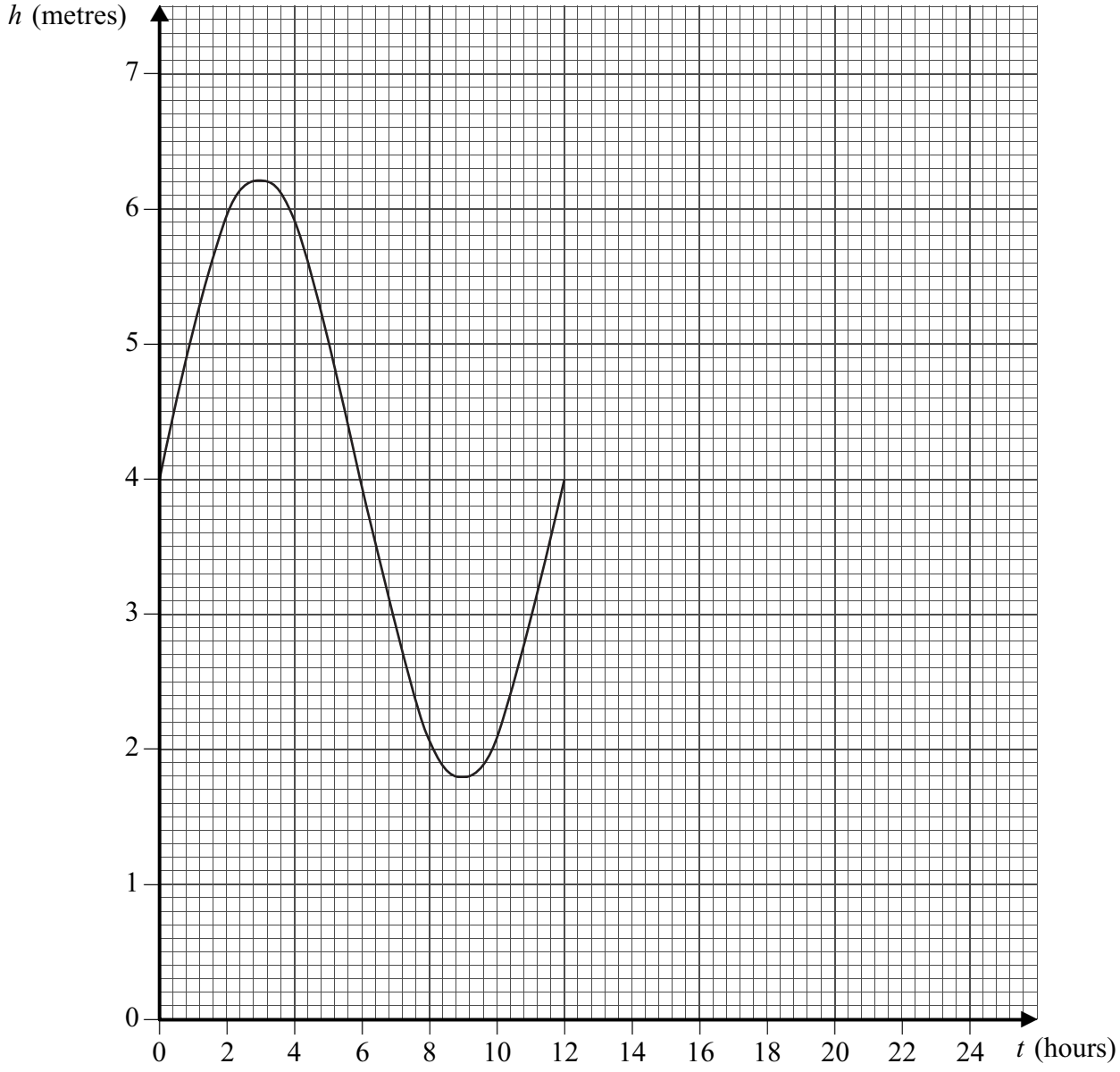


This graph is to be used when answering Question 2 (e).



This graph is to be used when answering Question 3 (d).

This graph is to be used when answering Questions 4 and 5.



END OF ANSWER SHEET

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